

Spatial modeling of plant distributions

Coupling Remote Sensing with GIS-based Models

Dissertation

To Fulfill the Requirements for the Degree of

„Doctor rerum naturalium“ (Dr. rer.nat.)



seit 1558

**Submitted to the Council of the
Faculty of Biology and Pharmacy
Of the Friedrich Schiller University Jena**

Master. Science. Hamidreza Keshtkar
born on 08/04/1981 in Iran

Jena, April 2016

Contents

Summary	IV
Zusammenfassung	VI
Manuscript overview and author contribution to the chapters of this thesis.....	VIII
Chapter 1. General Introduction.....	1
1.1. Ecological niche	1
1.2. Methodological improvements of SDMs	2
1.3. Evaluating the potential effects of climate change.....	3
1.4. Objectives and structure of the thesis	4
Chapter 2. Analysis of Landscape Changes Using Multi-Temporal Remote Sensing Imagery and Machine-Learning Classifier.....	7
2.1. Summary	7
2.2. Introduction	7
2.3. Materials and methods.....	10
2.3.1. Study area.....	10
2.3.2 Landsat image collection and pre-processing	10
2.3.3. Image Classification.....	11
2.3.4. Collection of training data.....	11
2.3.5. Pixel-based image classification	12
2.3.6. Object-based image classification.....	14
2.3.7. Accuracy assessment.....	16
2.3.8. Analyzing land-cover change.....	16
2.4. Results	17
2.4.1. Class Separability.....	17
2.4.2. Tuning of machine learning algorithm parameters	17
2.4.3. Accuracy assessment and statistical comparisons.....	18
2.4.4. Analysis of land-cover change	20
2.4.5. Land-cover changes in relation to topographic factors	23
2.5. Discussion and Conclusion	23
Chapter 3. A spatiotemporal analysis of landscape change using an integrated Markov chain and cellular automata models.....	28
3.1. Summary	28
3.2. Introduction	28
3.3. Materials and methods.....	30
3.3.1. Study areas	30
3.3.2. Modeling framework.....	30
3.4. Results	36
3.4.1. Land-cover Classification and Accuracy Assessment	36
3.4.2. Analysis of Landscape Metrics	36
3.4.3. Land-cover Modeling and Validation	37
3.4.4. Analysis of Simulation Results	39
3.5. Discussion and Conclusion	39
Chapter 4. Comparison of statistical models to predict the spatial distribution of plant species in Central Germany.....	44
4.1. Summary	44
4.2. Introduction	44
4.3. Methods.....	46
4.3.1. Study areas	46

4.3.2. Species and data preparation.....	46
4.3.3. Environmental predictors.....	47
4.3.4. Multi-collinearity analysis.....	48
4.3.5. Calibration of statistical models.....	48
4.3.6. Assessment of model performance.....	49
4.4. Results.....	49
4.4.1. Multi-collinearity among variables.....	49
4.4.2. Performance of distribution models.....	50
4.4.3. Comparison of models fitted with different explanatory.....	51
4.4.4. Comparison of models across species.....	52
4.5. Discussion.....	53
Chapter 5. Potential Impacts of Climate and Landscape Fragmentation Changes on Plant Distributions: Coupling Multi-Temporal Satellite Imagery with GIS-based Cellular Automata Model.....	57
5.1. Summary.....	57
5.2. Introduction.....	57
5.3. Materials and methods.....	60
5.3.1. Study areas.....	60
5.3.2. Species and data preparation.....	61
5.3.3. Modeling framework.....	61
5.4. Results.....	66
5.4.1. Model performance and contribution of predictors.....	66
5.4.2. Temporal landscape mapping.....	66
5.4.3. Projections of regional climate change.....	67
5.4.4. Projected distributions under different scenarios.....	67
5.5. Discussion.....	70
5.5.1. Effects of dispersal limitations.....	70
5.5.2. Effects of climate change scenarios.....	72
5.5.3. Effects of landscape change scenarios.....	73
5.5.4. Sources of uncertainty.....	74
5.6. Conclusion.....	75
Chapter 6. General Discussion.....	76
References.....	81
Appendix.....	94
Appendix B.....	99
Appendix C.....	100
Appendix D.....	101
Appendix E.....	102
Acknowledgments.....	103
Declaration.....	104